ANALYSIS OF WEST HACKBERRY INTERIM WITHDRAWAL SYSTEM

Kennith L. Goin
SPR Division 4543

James K. Linn
Geo Energy Systems Analysis 4744

W. D. Lyle, Jr.
Thermal Processes Division 4737

Sandia Laboratories
Albuquerque, NM 87185

ABSTRACT

An analysis of the West Hackberry interim withdrawal system has been conducted to determine if the interim raw water system and the ESR portion of the site were capable of meeting the 200 MBPD peak and 125 MBPD sustained interim withdrawal criteria.  The results presented herein indicate that this withdrawal criteria can be met subject to correction of some discrepancies in the valve schedule.

# TABLE OF CONTENTS

# LIST OF FIGURES

ANALYSIS CF WEST HACKBERRY INTERIM WITHDRAWAL SYSTEM

I. General Description

The drawdown plan [1] describes a system shown schematically in Figure 1 whereby a sustained withdrawal rate of 125,000 barrels of oil per day can be achieved. The peak capacity of the system is given as 200,000 BPD.

Raw water will be withdrawn from the alkali ditch and pumped to the raw water holding pond(s). As detailed in the Operating Procedure [2], the control for this bill be manual. Flow quantity can be controlled by change in pump speed and/or by the addition or deletion of pump units.

From the raw water holding pond(s), raw water is pumped into the selected cavern displacing oil which is then pumped or simply routed to the Eunoco terminals.

As detailed in the operating plans, when construction is complete, oil will be withdrawn from a single cavern, sequentially emptying all caverns in the order Nos. E, 11, 9, 7, and 60. 6. This effectively prevents commingling of oil types, but also maximizes the flow rates from individual caverns.

The valve schedule listing was reviewed in detail and several discrepancies were noted. Cil cannot be pumped off the site

with the valve schedule of the plan.  It appears that reversal
of valves 20F-4 and 20W-2 in the plan would be required.  Oil
from cavern 11 cannot be pumped off the site without also
opening valve 20F-2 and either 20F-1 or a combination of
other valves, which are not included in the valve schedule.

Other noted discrepancies in operating procedure which need
attention are:

1.  Valve 20F-5 should be listed with the water line instead of
    the brine manifold.

2.  valve 520G should be labeled 520D-1.

3.  The reason for the var ious (four ) "Brine System" schedules
    needs to be clarified.  These were uninterpretable as to
    their intent.

Some discrepancies were noted between the "design" [3] and
"as built" [4] drawings.  One example is the reversal of
labeling for oil lines #10CO-0034C and #10CO-0035C.

II.  Amoco Lock Raw Water Pipelines - Hydraulic Calculation
     During interim withdrawal, raw water will be pumped from the
     alkali ditch adjacent to the Amoco Locks to the West Hackberry
     brine pond through an existing 16" pipeline constructed earlier
     for interim oil fill.  A raw water intake structure and
     interconnecting pipe are being installed to complete the

withdrawal capability.  A steady state analysis of the interim raw water system was performed.  The structure and piping design information was provided by Jacobs/D'Appolonia Engineers and the SER Project Management Office.

The total pressure drop as computed For various flows are given in Table 1.  The nominal pressure head of the pumps being installed at the Amoco Locks is 125 psi.  As evident from the Table, this should be sufficient to maintain flow rates up to 200 MEPD, the maximum required.  The excess pressure will be dissipated in the exhaust into the holding pond.

TABLE 1

APPROXIMATE HYDRAULIC PRESSURE LOSS

WEST HACKBERRY INTERIM RAW WATER SUPPLY LINE

(AMOCOCOCK – RAW WATER POND)

| Flow Rate (MEPD) | Pressure Loss (PSI) |
|---|---|
| 75 | 16.57 |
| 100 | 29.0 |
| 125 | 41.7 |
| 150 | 6U.7 |
| 175 | E1.6 |
| 200 | 104.4 |

Control of the pipeline is maintained by one gate valve in each line near the intake, and the pump units.  The gate valves on

the individual lines (three pump lines) will necessarily need to be operated properly as a part of the pump operations. These valves are not mentioned in the drawdown plans but operation would be assumed as part of the pump operations.

I I Inter is: Withdrawal hydraulic Analysis

As previously stated, when construction is completed the interim withdrawal will be sequential starting with cavern 8, then 11, 9, 7, and 6. Since each cavern bill be operated separately and independently cf all others the hydraulic analysis presented below is valid only on a cavern basis. The pipe length and sizes were obtained from the "As Built" [4] drawings, and the percent flow from each well within a cavern was obtained by using the procedure detailed in Appendix K of Reference [5], and is displayed in Table 2.

TABLE 2

CAVERN WELL FLOW

| Well | Percent of Total Cavern Flow |
|---|---|
| 6 (slick) | 52.6 |
| 6A* | 15.8 |
| 6B | 15.8 |
| 6C | 15.6 |
| 7, 8, 9, 13 (slick) | 6E. 6 |
| 7A, 8A, 9A, 11A | 18. 7 |
| 7B, 8B, 9B, 11B | 16. 7 |

*This well not yet complete

The raw water booster pumps were assumed to produce a differential head of 250 psi for all flows, and the metering station was assumed to have a 20 psi drop. In addition, it was assumed that the Texoma delivery pressure was 50 psig at all flow rates and **that** the West Hackberry gauge on the 42 inch offsite pipeline was maintained at 50 psig in accordance with Ref [2] The results of the analysis are contained in Figures 2 - t for each cavern. Each figure contains a curve showing the pressure drop across the cavern oil flow control valve along with a curve for pressure drop corresponding the valve cavitation. The pressure drop curve for cavitation corresponds to 0.75 times the valve inlet pressure. This pressure drop criteria for cavitation Gras a value suggested for expected operating pressures by the valve manufacturer. It is noted that pressure drops greater than the booster pump discharge pressures are possible because of the water-brine and oil head differentials in the caverns. Non-cavitation operation occurs whenever the cavitation 1 ine is above the control valve pressure drop, OK stated another way whenever the pressure drop across the valves is less than 75 percent of the valve inlet pressure. Table 3 summarizes the operating ranges for the various caverns. The minimum flow rates** are rates below which the cavern oil valves will be in the cavitation region and the flow limitations column lists maximum flows that can be obtained.

---

**These results assume all wells of Table 2 within each cavern ire operating.

TABLE 3

CAVERN OPERATING RANGES FOR INTERIM WITHDRAWAL

| Cavern | Min Flow For Non-Cavitation (BPD) | Flow Limitations (BPD) |
|--------|-----------------------------------|------------------------|
| 6 | 190,000 | ~200,000 |
| 7 | 100,000 | 135,000 |
| 8 | 110,000 | ≥200,000 |
| 9 | 130,000 | ≥200,000 |
| 11 | 75,000 | 145,000 |

The conclusion of the hydraulic analysis is that an average sustained flow of 125,000 BBD is well within the capabilities of the interim withdrawal system.

IV.   Pumps for West Hackberry Interim Withdrawal System

At the Amoco dock, the pumping station includes three diesel driven pumps, each of which is rated for a flow of 3000 gpm (103,000 BPD) at a pressure of 125 psi. These pumps were installed and given an operating check in May .   They are adequate to support the emergency 200,000 BPD withdrawal rate [ 1] with one spare pump.

Raw water from the South Brine pond kill be picked up by the brine/raw water booster pump station for injection into the caverns.   This booster pump station includes four pumps each of which is rated for 89,000 BPD, and two pumps each of which is rated for 172,000 BPD.   Discharge pressure for all pumps at rated flow is 250 psi.   Two or three of the booster pumps

will provide the required flow for withdrawal of 200,000 BPD. The 250 psi discharge pressure may be adequate for withdrawal at a rate of 200,000 BPD. however, if not, the three water injection pumps (24, 25, and 26) each have a flow capacity of 140,000 BPD at a discharge pressure of 520 psi.

V.    "Fault Analysis" of Interim hithdrawal

As part of the evaluation of the Interim kithdrawal System, several events were identified which could create serious difficulties. These events would occur usually only as a human control failure or as a system component failure. The usefulness in identifying such events lies in the increased vigilance which could be implemented to prevent them.

The events are detailed below:

1.   The raw water and oil can be mixed if valve 201-2 is opened. This can, at the worst, send oil to the brine wells.

2.   Lue to the discrepancies in drawings, it is plausible that the simultaneous raw water injection and oil withdrawal will be attempted on separate caverns, at least momentarily. The pressures are such that no damage should result to caverns, or pipel ines. If allowed to persist, pump units could be damaged.

3.   Control valves are used for dropping considerable pressures during any low flow rate periods. Prolonged operation in such a mode would be detrimental to the valves.
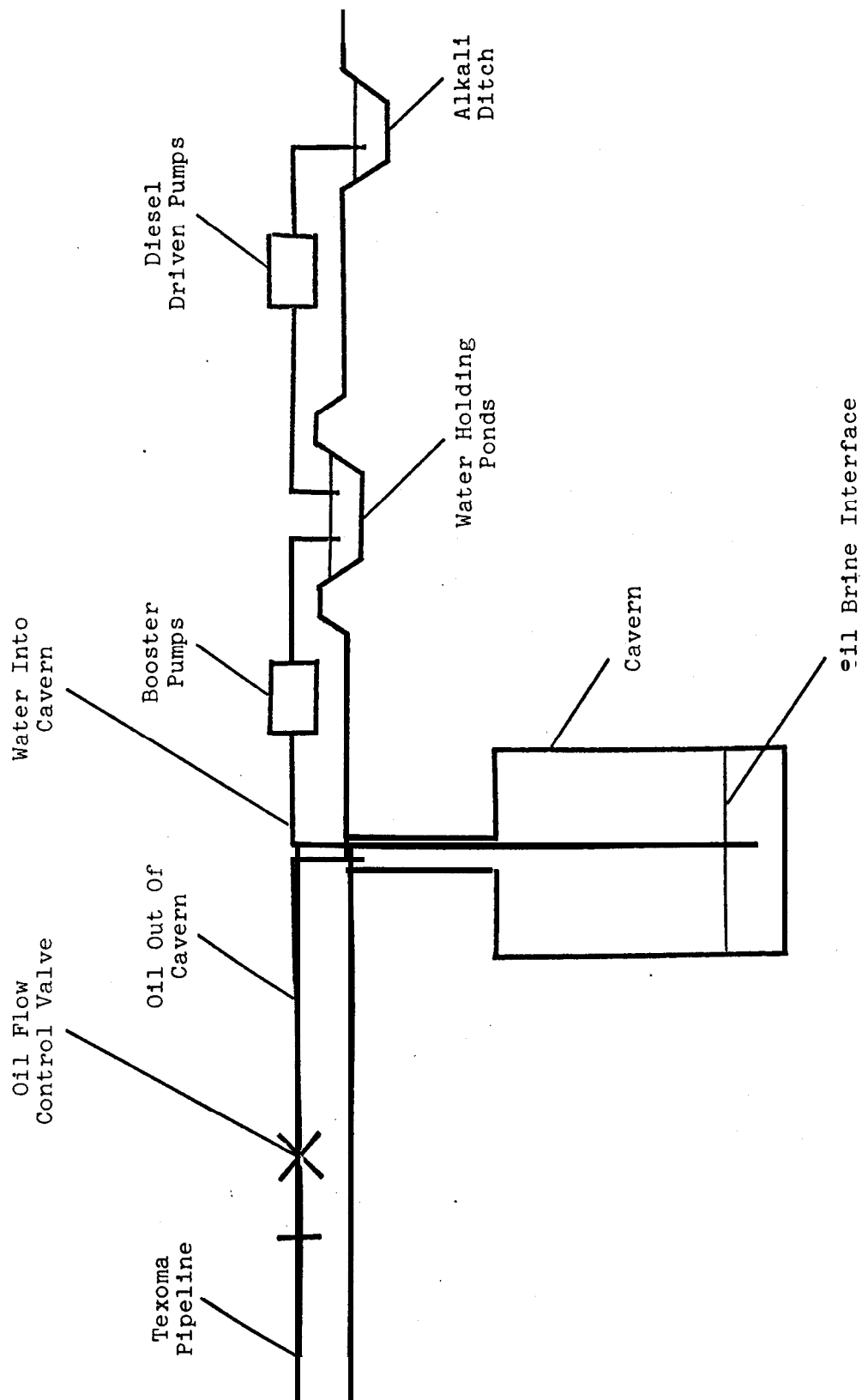
Oil Flow
Control Valve

Water Into
Cavern

Diesel
Driven Pumps

Alkali
Ditch

Booster
Pumps

Water Holding
Ponds

Oil Out Of
Cavern

Cavern

Texoma
Pipeline

Oil Brine Interface

FIGURE 1

SCHEMATIC OF INTERIM WITHDRAWAL SYSTEM
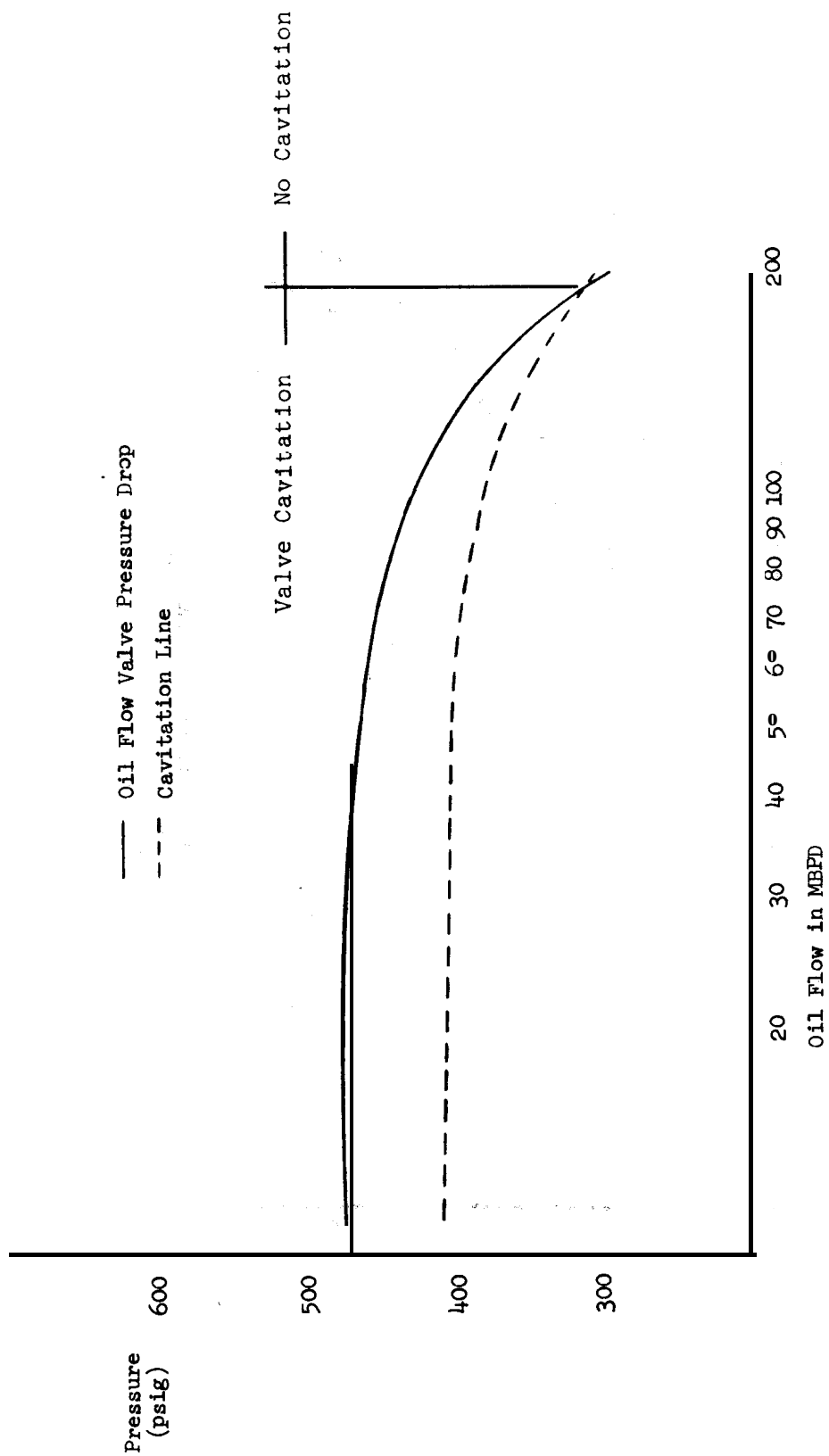
FIGURE 2

CAVERN 6 PRESSURE CURVES

13
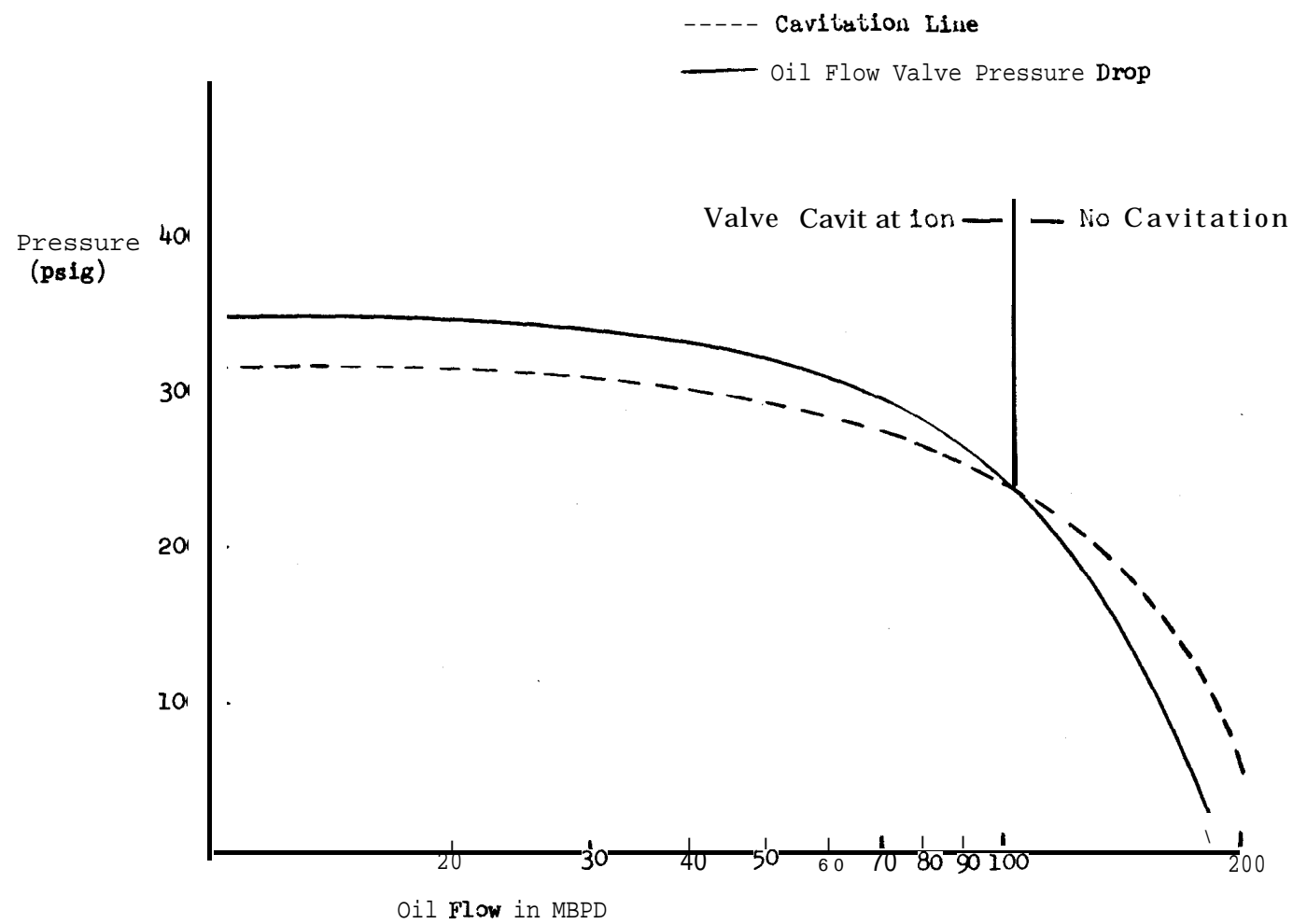
FIGURE 3

CAVERN 7 PRESSURE CURVES

14

----- Cavitation Line
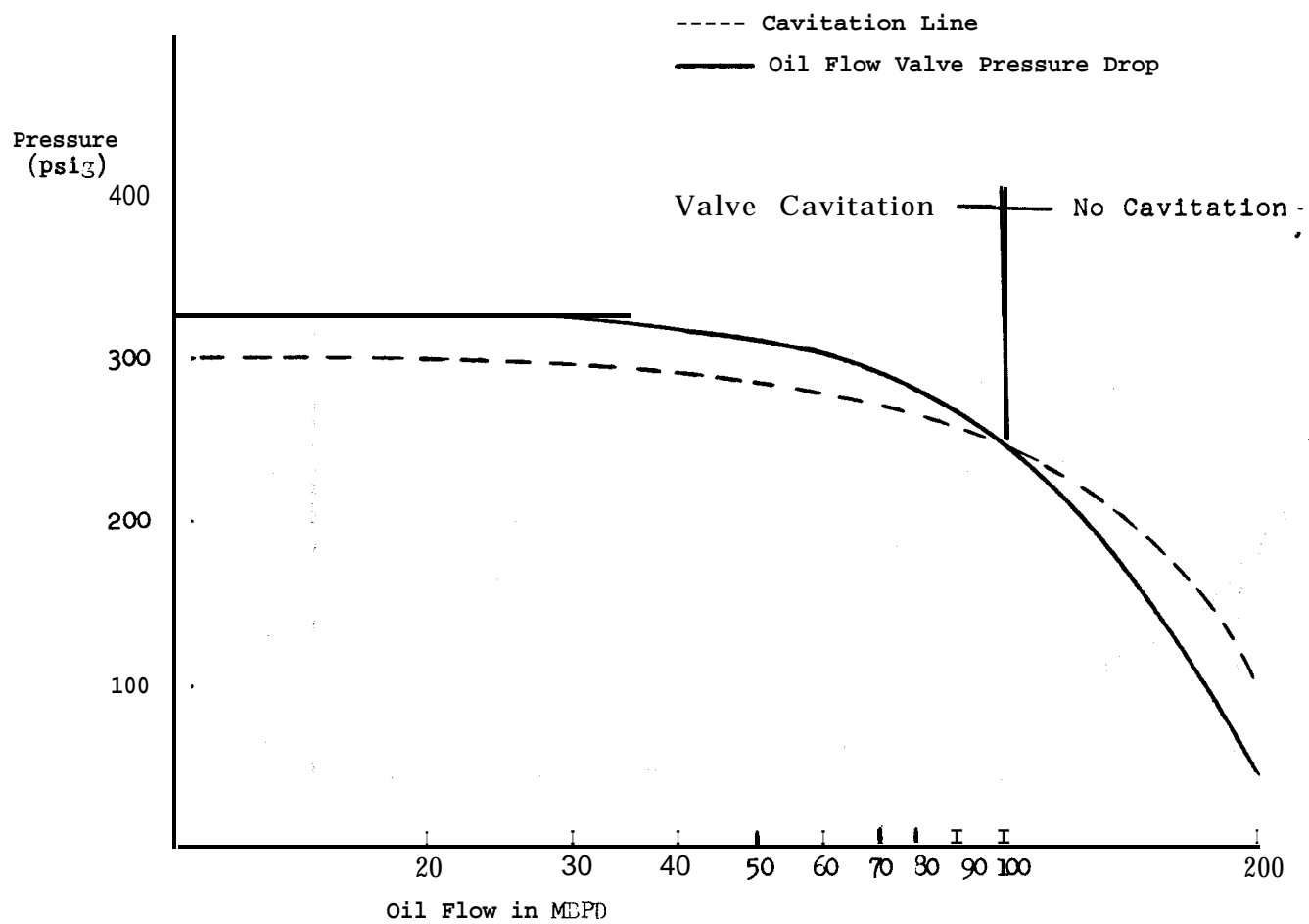
——— Oil Flow Valve Pressure Drop

Pressure
(psig)

400

Valve  Cavitation ——┃— No Cavitation

300

200

100

20      30      40    50   60  70  80  90 100                200

Oil Flow in MBPD

FIGURE 4

CAVER: 3 **PRESS RE** CURVES
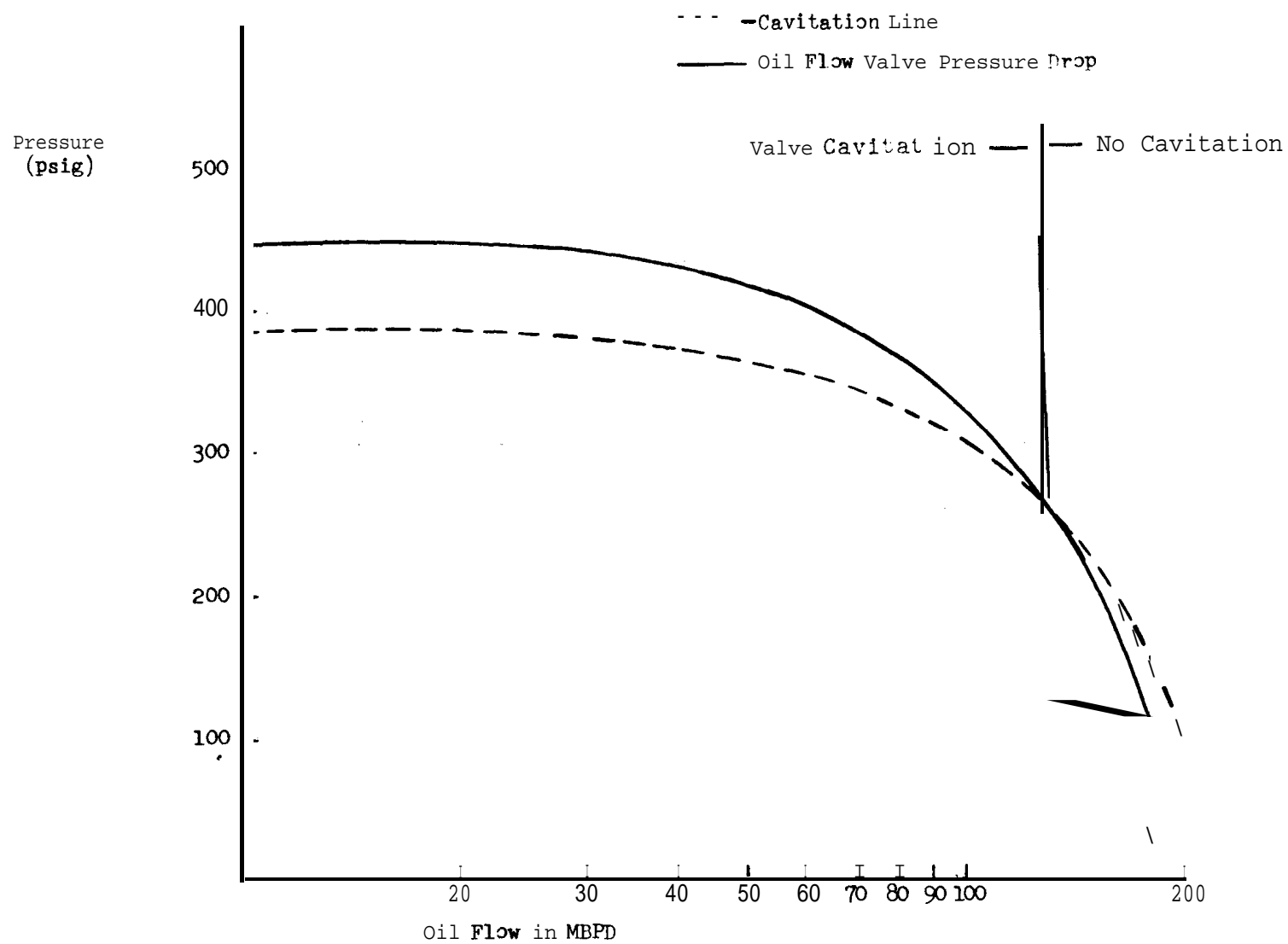
FIGURE 5
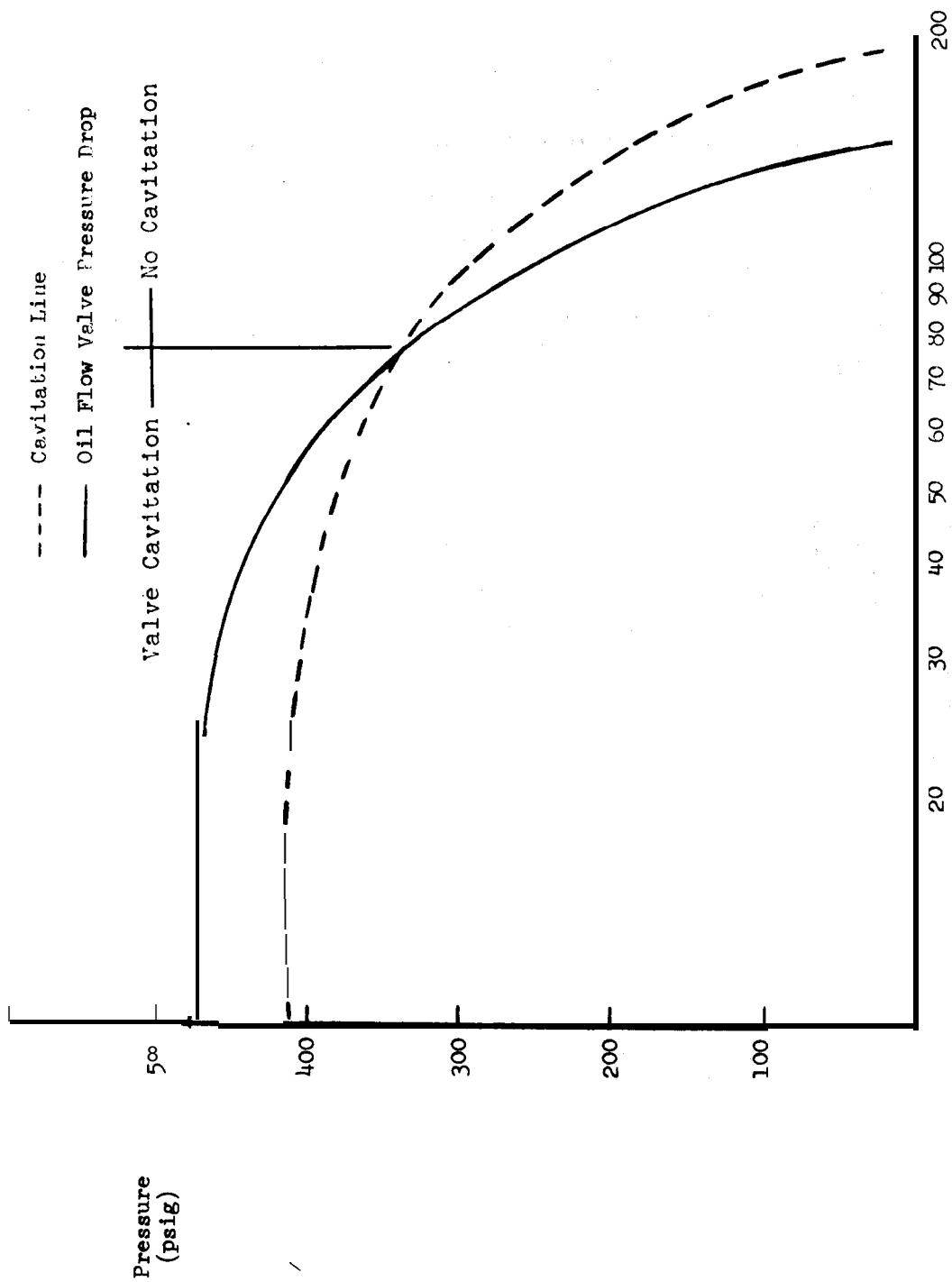CAVERN 9 PRESSURE CURVES

FIGURE 6
CAVERN 11 PRESSURE CURVES

- - - - Cavitation Line

———— Oil Flow Valve Pressure Drop

No Cavitation

Valve Cavitation

Pressure (psig)

Oil Flow in MBPD

17

## References

1. Dravo Utility Constructors Inc., West Hackberry Interim **Drawdown** Plan, May 21, 1979.

2. West Hackberry Interim **Drawdown** Operating Procedure.

3. West Hackberry Drawings WH-9 and WH-23.

4. Obtained from Assistant SPR Site Manager, West Hackberry; West Hackberry "As Built" Drawings,

5. Systems Integration and Engineering Support Study for the Strategic Petroleum Reserve (SPR) Program, SAND **79-0637,** June 1979.